MAR Pediatrics (2026) 7:2

Research Article

Prospective Evaluation of a Pediatric Early Warning Scoring System among Children Attending a Pediatric Intermediate Care Unit

Eman Mohamed Khaled, MD *[1], Manal Mohamed Zaher, MD [2], Naglaa Abdel-Monaem, MD [3], Rania Salah Hafez Abd El-Megid [4]

1. *Professor of Pediatrics, Faculty of Medicine for Girls, Al-Azhar University, Cairo, Egypt.*
2. *Assistant Professor of Pediatrics, Faculty of Medicine for Girls, Al-Azhar University, Cairo, Egypt.*
3. *Lecturer of Pediatrics, Faculty of Medicine for Girls, Al-Azhar University, Cairo, Egypt.*
4. *Pediatrician, Teaching Hospital (MTH), GOTHI, Cairo, Egypt.*

***Correspondence to:** Eman Mohamed Khaled, Professor of Pediatrics, Faculty of Medicine for Girls, Al-Azhar University, Cairo, Egypt.

Copyright

Received: 04 February 2026

Published: 01 March 2026

DOI: https://doi.org/10.5281/zenodo.18830174

Abstract

Background: *Early clinical deterioration in hospitalized children is often preceded by subtle physiological abnormalities that may go unrecognized. Pediatric Early Warning Scores (PEWS) standardize bedside assessment to identify deterioration early, but data from pediatric intermediate care units are limited.*

Objective: *To evaluate the effectiveness of the bedside Pediatric Early Warning Score (PEWS) in identifying clinical deterioration among children admitted to a pediatric intermediate care unit (PIMCU), using unplanned transfer to a Pediatric Intensive Care Unit (PICU) as the primary outcome.*

Methods: *This prospective observational study included 201 children admitted to the PIMCU at Al-Zahraa University Hospital, a tertiary university hospital in Cairo, Egypt. PEWS was calculated at admission and prior to discharge or PICU or general ward transfer using the bedside score described by Parshuram et al. 2011. Patients were grouped by unplanned PICU transfer status. Clinical, laboratory, and PEWS variables were compared between groups. Receiver operating characteristic (ROC) curve analysis was performed to determine the predictive performance and optimal PEWS cutoff.*

Results: *Of 201 patients, 92.5% were discharged home or to the ward, while 7.5% required unplanned PICU transfer. The mean age was 2.19 ± 2.75 years; 52.2% were male. Respiratory disorders were the most common primary diagnosis. Patients requiring PICU transfer had significantly higher PEWS at admission than non-transferred patients (3.80 ± 2.65 vs. 2.05 ± 1.69; $p < 0.001$), and increased further before transfer (8.33 ± 2.66). A PEWS cutoff ≥4 predicted PICU transfer with 93.3% sensitivity and 91.8% specificity (AUC 0.94, 95% CI: 0.88–0.99). Higher PEWS values correlated significantly with abnormalities in heart rate, respiratory rate, oxygen saturation, and systolic blood pressure ($p < 0.05$), but not with laboratory parameters.*

Conclusions: *The bedside PEWS is a reliable and practical tool for early identification of clinical deterioration in pediatric intermediate care units. Routine implementation of PEWS may support. timely escalation of care, reduce unplanned PICU transfers, and enhance patient safety, particularly in resource-limited settings.*

Keywords: *Pediatric Early Warning Score; Clinical deterioration; Pediatric Intermediate Care Unit; PICU transfer; Physiologic monitoring; Patient safety.*

Introduction

Clinical deterioration in hospitalized children often precedes cardiopulmonary arrest and is associated with significant morbidity and mortality, much of which may be preventable through timely recognition and intervention [1–3]. Early identification of at-risk children and prompt escalation of care are therefore critical strategies to reduce unplanned pediatric intensive care unit (PICU) admissions and improve outcomes [4]. Various tools, including severity-of-illness scores and structured calling criteria, have been developed to assist clinicians in detecting early deterioration [5]. However, many of these systems are complex, require multiple variables or laboratory investigations, and are challenging to implement consistently at the bedside, limiting their practical utility [6]. Moreover, track-and-trigger systems designed for adult patients cannot be directly applied to children due to age-related physiological differences [7].

The Pediatric Early Warning Score (PEWS) was developed to overcome these limitations. It is a simple, user-friendly bedside tool tailored to pediatric patients, incorporating readily available clinical parameters to provide a structured assessment of physiological status [8]. Elevated PEWS values have been consistently associated with an increased risk of clinical deterioration and the need for escalation of care [9–11]. Both prospective and retrospective studies have validated the predictive accuracy of PEWS, and refinements in age-specific vital sign criteria have further enhanced its performance [10,11]. Despite this evidence, early signs of deterioration are frequently missed in clinical practice, highlighting the continued need for structured pediatric early warning systems [12].

PEWS assesses three core domains: behavior, cardiovascular status, and respiratory function, and scores typically rise in the hours preceding clinical deterioration, allowing for timely intervention [11]. While PEWS has been extensively studied in general pediatric ward settings, prospective data evaluating its bedside performance specifically in Pediatric Intermediate Care Units (PIMCUs) are limited. This gap is particularly important in resource-constrained settings, where delays in escalation may result in adverse outcomes.

Accordingly, this study aimed to prospectively evaluate the performance of the bedside Pediatric Early Warning Score in predicting clinical deterioration among children admitted to a PIMCU, using unplanned transfer to the PICU as the primary outcome.

Methods

Study Design and Participants: This prospective, observational study included 201 patients admitted to the Pediatric Intermediate Care Unit (PIMCU) at Al-Zahraa University Hospital between April 2013 and April 2014. Patients were categorized into two groups based on clinical outcomes: those discharged home or transferred to general pediatric wards (Group 1) and those requiring unplanned transfer to the Pediatric

Intensive Care Unit (PICU) (Group 2).

Inclusion criteria were children aged 1 month to 18 years admitted to the PIMCU from the emergency department, outpatient clinic, or inpatient wards, meeting the intermediate care criteria described by Jaimovich et al. [13]. Exclusion criteria were neonates, patients admitted directly to the PICU, and non-critical cases admitted to inpatient wards.

Data Collection: All patients underwent detailed history taking, comprehensive clinical examination, and relevant laboratory investigations. Laboratory assessments included complete blood count (CBC), arterial blood gases (ABG), erythrocyte sedimentation rate (ESR), electrolytes, random blood sugar, liver function tests (ALT, AST, albumin), renal function tests (blood urea nitrogen [BUN], serum creatinine), and additional tests such as coagulation profile, cultures, or imaging as clinically indicated.

PEWS Assessment: Clinical status was evaluated using the bedside Pediatric Early Warning Score (PEWS) described by Parshuram et al. [14] (Tables 1–2). Parameters included heart rate, systolic blood pressure, capillary refill, respiratory rate, oxygen saturation, oxygen therapy, and respiratory effort. Age-specific reference ranges were applied for heart rate, systolic blood pressure, and respiratory rate, while respiratory effort was categorized as mild, moderate, or severe. Nursing and medical staff received standardized training on PEWS scoring prior to study initiation.

PEWS was recorded at admission and prior to discharge or transfer. Incomplete admission observations were repeated within 30 minutes. Total PEWS scores were calculated by summing component subscores.

Component	**Age Group**	**0**	**1**	**2**	**4**
Heart rate (beats/min)	<3 months	>110 and <150	≥150 or ≤90	≥180 or ≤90	≥190 or ≤80
	3 to <12 months	>100 and <150	≥150 or ≤100	≥170 or ≤80	≥180 or ≤70
	1 to 4 years	>90 and <120	≥120 or ≤90	≥150 or ≤70	≥170 or ≤60
	5 to <12 years	>70 and <110	≥110 or ≤70	≥130 or ≤60	≥150 or ≤50
	≥12 years	>60 and <100	≥100 or ≤60	≥120 or ≤50	≥140 or ≤40
Systolic blood pressure (mmHg)	<3 months	>60 and <80	≥80 or ≤60	≥100 or ≤50	≥130 or ≤45
	3 to <12 months	>80 and <100	≥100 or ≤80	≥120 or ≤70	≥150 or ≤60

	1 to 4 years	>90 and <110	≥110 or ≤90	≥125 or ≤75	≥160 or ≤65
	5 to <12 years	>90 and <120	≥120 or ≤90	≥140 or ≤80	≥170 or ≤70
	≥12 years	>100 and <130	≥130 or ≤100	≥150 or ≤85	≥190 or ≤75
Capillary refill (seconds)	All ages	<3	≥3	—	—
Respiratory rate(breaths/min)	<3 months	>29 and <61	≥61 or ≤29	≥81 or ≤19	≥91 or ≤15
	3 to <12 months	>24 and <51	≥51 or ≤24	≥71 or ≤19	≥81 or ≤15
	1 to 4 years	>19 and <41	≥41 or ≤19	≥61 or ≤15	≥71 or ≤12
	5 to <12 years	>19 and <31	≥31 or ≤19	≥41 or ≤14	≥51 or ≤10
	≥12 years	>11 and <17	≥17 or ≤11	≥23 or ≤10	≥30 or ≤9
Respiratory effort	All ages	Normal	Mild increase	Moderate increase	Severe increase or apnea
Oxygen saturation (%)	All ages	>94	91–94	≤90	—
Oxygen therapy	All ages	Room air	Any: <4 L/min or <50% FiO2	—	≥4 L/min or ≥50% FiO2

Table 1. Components and scoring criteria of the bedside Pediatric Early Warning Score (PEWS) [14]

Respiratory Effort	**Criteria**
Mild	Nasal flaring, subcostal and intercostal retractions
Moderate	Two or more mild criteria, or substernal retractions, wheezing, crackles/rales, prolonged expiration
Severe	Two or more moderate criteria, or bradypnea, supraclavicular, suprasternal, sternal retractions, head bobbing, seesaw respirations, stridor, grunting, decreased respiratory rate, shallow or labored respirations

Table 2. Definitions of respiratory effort categories used in PEWS scoring [14]

Statistical Analysis and Ethics:

Data were analyzed using SPSS version 17. Continuous variables are presented as mean ± standard deviation (SD) and categorical variables as counts and percentages. Group comparisons were conducted using independent t-tests for continuous variables and chi-square or Fisher's exact tests for categorical variables. Within-group comparisons were performed using paired t-tests. Spearman correlation coefficients were calculated to assess associations between PEWS and physiological or laboratory parameters.

Receiver operating characteristic (ROC) curve analysis determined the optimal PEWS cutoff for predicting unplanned PICU transfer. The area under the curve (AUC) with 95% confidence intervals was calculated using the Hanley–McNeil method. Statistical significance was set at $p < 0.05$. A post-hoc power analysis based on the observed difference in PEWS between children requiring PICU transfer and those who remained stable indicated a large effect size (Cohen's $d \approx 0.99$). Despite the small number of PICU-transferred patients ($n = 15$), the study achieved a statistical power of approximately 96%, confirming that the sample size was sufficient to detect clinically meaningful differences.

The study was approved by the Ethics Committee of Al-Zahraa University Hospital. At the time of approval, formal reference numbers were not routinely assigned. Verbal informed consent was obtained from the parents or guardians of all participants, and confidentiality was maintained throughout the study.

Results

Baseline Characteristics: A total of 201 children admitted to the Pediatric Intermediate Care Unit (PIMCU) were included in the analysis. Of these, 186 patients (92.5%) were discharged home or transferred to general pediatric wards (Group 1), while 15 patients (7.5%) required unplanned transfer to the Pediatric Intensive Care Unit (PICU) (Group 2).

The overall mean age was 2.19 ± 2.75 years, with a slight male predominance (52.2%). The mean body mass index (BMI) was 16.48 ± 4.05 kg/m² (range: 9.57–42.87), and overall mean duration of PIMCU stay was 2.28 ± 0.69 days. Previous hospital admission was reported in 37.8% of patients, including 23.9% with prior PIMCU admission and 3.5% with a history of PICU admission.

There were no significant differences between groups regarding gender, weight, height, or BMI. Children who required unplanned PICU transfer were slightly older than those who became clinically stable (2.40 ± 2.60 vs. 2.16 ± 2.75 years; $p = 0.045$) and had a significantly shorter PIMCU length of stay (2.20 ± 1.70 vs. 3.42 ± 1.18 days; $p = 0.004$). A higher proportion of PICU- transferred patients had a history of prior PICU admission compared with Group 1 (13.3% vs. 2.7%; $p = 0.031$). Most unplanned PICU transfers occurred within the first 24 hours of admission (46.7% vs. 3.8%; $p < 0.001$).

Respiratory disorders were the most common primary diagnosis in both groups, followed by renal (including chronic kidney disease), cardiovascular, gastrointestinal, and neurological disorders among PICU-transferred patients. Weight-for-age below the 3rd percentile was significantly more frequent in Group 2 (p = 0.047), whereas height/length percentiles did not differ significantly between groups (Table 3).

Variable	Total (n = 201)	Group 1 (n = 186)	Group 2 (n = 15)	*p*-value
Age (years), mean ± SD	2.19 ± 2.75	2.16 ± 2.75	2.40 ± 2.60	0.045
Male sex, n (%)	105 (52.2)	99 (53.2)	6 (40.0)	0.324
Weight (kg), mean ± SD	11.0 ± 7.95	11.0 ± 7.8	11.4 ± 9.7	0.824
Length/height (cm), mean ± SD	78.1 ± 21.7	78.1 ± 21.8	78.2 ± 20.9	0.856
BMI (kg/m²), mean ± SD	16.48 ± 4.05	16.53 ± 3.86	15.86 ± 6.05	0.542
Length of stay in PIMCU, mean ± SD	2.28 ± 0.69	3.42 ± 1.18	2.20 ± 1.70	0.004
Previous hospital admission, n (%)	76 (37.8)	62 (33.3)	7 (46.7)	0.295
Previous PICU admission, n (%)	7 (3.5)	5 (2.7)	2 (13.3)	0.031
Weight-for-age <3rd centile, n (%)	19 (9.5)	15 (8.1)	4 (26.7)	0.047
Height/length-for-age <3rd centile, n (%)	13 (6.5)	11 (5.9)	2 (13.3)	0.824

Table 3. Demographic and clinical characteristics of study groups

Laboratory Findings: Patients requiring unplanned PICU transfer demonstrated significantly lower hemoglobin, hematocrit, and red blood cell counts (all p ≤ 0.001), alongside higher white blood cell counts (p < 0.001) and increased red cell distribution width (RDW) (p = 0.001) compared with Group 1.

Patients transferred to PICU had significantly lower arterial pH and higher rates of metabolic and respiratory acidosis (p = 0.017 and 0.009, respectively). Renal function was markedly impaired in Group 2, as evidenced by significantly elevated serum urea and creatinine levels; notably, all cases of impaired renal function (serum creatinine >1.5 mg/dL) occurred exclusively among PICU- transferred patients. Electrolyte abnormalities were generally comparable between groups, except for significantly higher serum potassium levels in Group 2 (p = 0.009) (Table 4).

Parameter	Group 1 (n = 186) Mean ± SD	Group 2 (n = 15) Mean ± SD	p-value
CBC			
Hemoglobin (g/dL)	9.88 ± 1.63	8.14 ± 2.18	0.001
Hematocrit (%)	30.65 ± 4.08	22.87 ± 6.83	<0.001
WBC ($\times 10^3/\mu L$)	9.94 ± 4.38	15.68 ± 9.54	<0.001
RBC ($\times 10^6/\mu L$)	4.23 ± 0.86	3.35 ± 0.86	0.001
RDW (fL)	14.93 ± 2.26	17.42 ± 3.13	0.001
ABG			
pH	7.39 ± 0.05	7.18 ± 0.31	<0.001
PCO_2 (mmHg)	34.87 ± 8.22	37.1 ± 16.62	0.540
PO_2 (mmHg)	84.36 ± 29.24	100.19 ± 50.45	0.196
HCO_3 (mmol/L)	21.68 ± 4.7	18.82 ± 7.45	0.137
BE (mmol/L)	-3.25 ± 3.39	-5.69 ± 9.18	0.161
Electrolytes			
Potassium (mEq/L)	4.26 ± 0.77	4.95 ± 1.58	0.009
Renal function			
Creatinine (mg/dL)	0.26 ± 0.12	2.16 ± 3.41	<0.001
Urea (mg/dL)	17.33 ± 11.16	95.73 ± 144.57	0.001
Impaired renal function (Creatinine >1.5 mg/dL), n (%)	0 (0)	3 (20)	<0.001

Values are mean ± SD or n (%). CBC = complete blood count; ABG = arterial blood gas; RDW = red cell distribution width; BE = base excess.

Table 4. Laboratory Parameters of studied groups

Therapeutic Interventions: Intravenous antibiotics were administered to the majority of patients (91.0%), with no significant differences between groups. Other therapeutic interventions, including nebulized bronchodilators, intravenous fluid therapy, oxygen supplementation, bronchodilator therapy, and packed red blood cell transfusions, were used at comparable rates in both groups (Table 5).

Therapeutic interventions	Group 1 (n = 186) n (%)	Group 2 (n = 15) n (%)	p-value
IV antibiotics	168 (90.3)	15 (100)	0.428
Nebulized bronchodilator	80 (43.0)	7 (46.7)	0.996
IV rehydration	77 (41.4)	2 (13.3)	0.062
Oxygen supplementation	61 (32.8)	9 (60.0)	0.064
Bronchodilator therapy	32 (17.2)	3 (20.0)	0.936
IV packed RBC transfusion	5 (2.7)	2 (13.3)	0.152

Values are presented as n (%). RBC = red blood cells; IV = intravenous.

Table 5. Therapeutic interventions of studied groups

Clinical Indications for PICU Transfer: The most common indication for unplanned PICU transfer was increased respiratory effort despite preserved oxygen saturation (SpO_2 >90%), accounting for 66.7% of cases. Additional indications included status epilepticus (13.3%), altered level of consciousness (Glasgow Coma Scale score of 8), bleeding tendency, and hypoxemia (SpO_2 <90%) unresponsive to oxygen therapy (6.7% each).

Pediatric Early Warning Score (PEWS) Analysis: Patients who required unplanned PICU transfer had significantly higher PEWS values at admission compared with those who became clinically stable (3.80 ± 2.65 vs. 2.05 ± 1.69; $p < 0.001$). PEWS increased markedly prior to PICU transfer (8.33 ± 2.66), whereas scores declined significantly among clinically stable patients before discharge (0.71 ± 0.79; $p < 0.001$) (Table 6).

PEWS score	Group 1	Group 2	p-value
On admission	2.05 ± 1.69	3.80 ± 2.65	<0.001
Prior to discharge/transfer	0.71 ± 0.79	8.33 ± 2.66	<0.001

Table 6. PEWS scores of studied groups

At admission, a PEWS cutoff of ≥4 predicted unplanned PICU transfer with an area under the ROC curve (AUC) of 0.94, sensitivity of 93.3%, specificity of 91.8%, positive predictive value (PPV) of 48.3%, and negative predictive value (NPV) of 99.4%. Prior to PICU transfer, a cutoff value >4 showed even higher predictive accuracy (AUC = 0.994), with sensitivity of 93.3%, specificity of 98.9%, PPV of 87.5%, and NPV of 99.5% (Table 7, Figures 1–2).

Time point	PEWS cutoff	AUC	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
At admission	≥4	0.94	93.33	91.85	48.3	99.4
Prior to PICU transfer	>4	0.994	93.33	98.92	87.5	99.5

Values are based on PEWS cutoffs at admission and prior to PICU transfer. AUC = area under the curve; PPV = positive predictive value; NPV = negative predictive value.

Table 7. Predictive performance of PEWS for unplanned PICU transfer

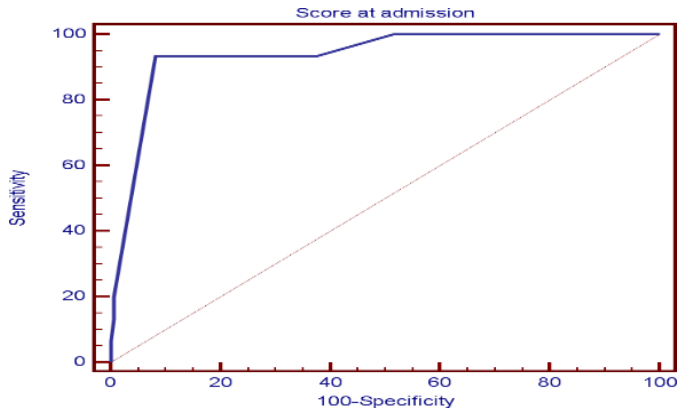


Figure (1): ROC curve showing the diagnostic performance of the bedside PEWS at admission (AUC = 0.94)

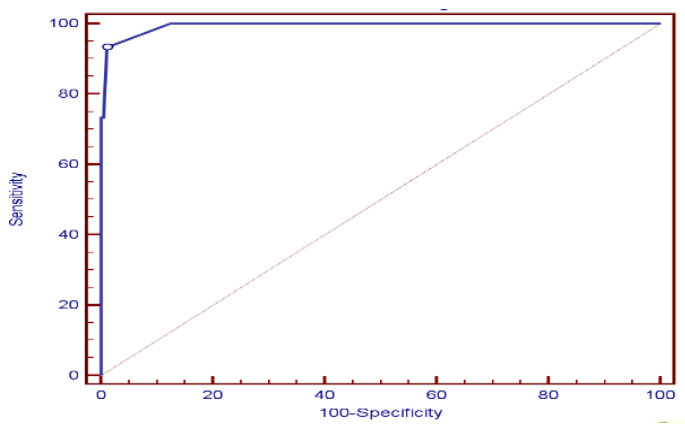


Figure (2): ROC curve showing the diagnostic performance of the bedside PEWS prior to PICU transfer (AUC = 0.994)

Correlation analysis demonstrated significant positive associations between PEWS and heart rate ($r = 0.451$, $p < 0.001$), respiratory rate ($r = 0.308$, $p < 0.001$), and respiratory effort ($r = 0.581$, $p = 0.023$). PEWS was negatively correlated with oxygen saturation ($r = -0.249$, $p = 0.001$) and systolic blood pressure ($r = -0.183$, $p = 0.012$). No significant correlations were observed between PEWS and laboratory parameters, including complete blood count or arterial blood gas variables (Figures 3 A-E).

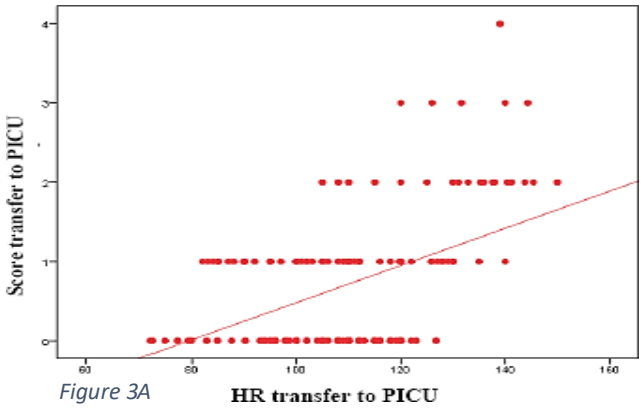


Figure 3A

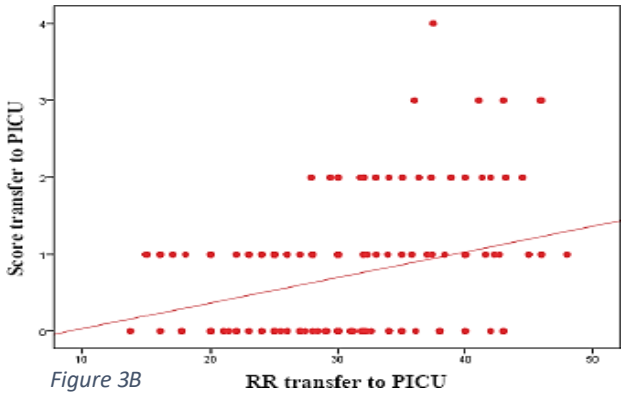


Figure 3B

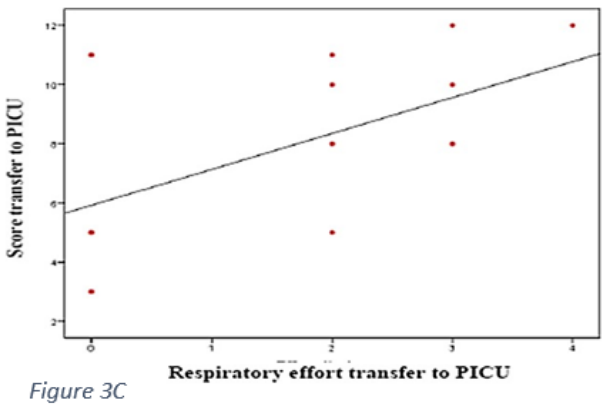
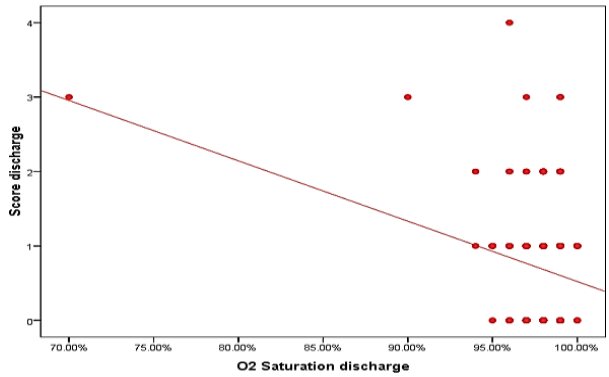


Figure 3C



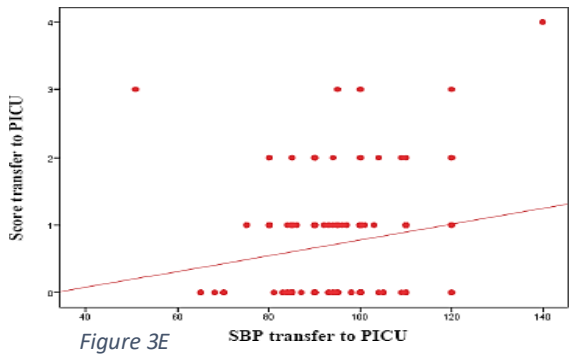


Figure 3E

Figure 3. Correlation between PEWS score and clinical parameters at time of transfer to PICU: (A) heart rate, (B) respiratory rate, (C) respiratory effort, (D) SpO_2, (E) systolic blood pressure

Discussion

Timely recognition of clinical deterioration in hospitalized children remains a persistent challenge, particularly in Pediatric Intermediate Care Units (PIMCUs), where patient acuity is high and early physiological changes may be missed during periods of heavy clinical workload. PIMCUs occupy a critical position between general pediatric wards and Pediatric Intensive Care Units (PICUs), caring for children who are clinically unstable yet do not initially meet criteria for intensive care. Compared with PICUs, PIMCUs often operate with lower nurse-to-patient ratios and limited continuous monitoring, increasing dependence on structured bedside assessment tools to support early identification of deterioration.

The present study prospectively evaluated the utility of the bedside Pediatric Early Warning Score (PEWS) in detecting clinical deterioration early among children admitted to a PIMCU, using unplanned PICU transfer as a surrogate outcome. In this cohort, 7.5% of patients required unplanned transfer to the PICU, a proportion consistent with previously reported rates ranging from 1.8% to 17% in pediatric intermediate or high-dependency care settings [4,15,16]. Variability across studies likely reflects differences in patient case mix, institutional admission criteria, and thresholds for escalation of care.

A significant association was observed between prior PICU admission and subsequent unplanned transfer during the current hospitalization (13.3%, $p = 0.031$), suggesting that patients with a history of critical illness represent a particularly vulnerable subgroup requiring closer surveillance. Similar associations have been reported by Duncan et al. and Parshuram et al., although inconsistencies across studies highlight the influence of population characteristics and care environments on deterioration risk [14,15,17].

Respiratory disorders, including pneumonia, bronchiolitis, asthma, and croup, were the most common primary diagnoses in both PICU transferred and non-transferred patients, and progressive respiratory distress was the predominant indication for PICU transfer. This observation is consistent with extensive literature identifying respiratory compromise as the leading cause of pediatric clinical deterioration and PICU admission [18–20]. Importantly, early warning systems that prioritize respiratory parameters have been shown to outperform those relying primarily on late hemodynamic markers, such as hypotension, in predicting clinical decline [3,21,22].

The bedside PEWS evaluated in this study, originally developed by Parshuram et al., incorporates seven age-adjusted physiological variables with clearly defined scoring criteria [14]. Compared with more complex early warning systems that include up to 14–19 variables, this PEWS offers simplicity, ease of bedside application, and high clinical usability. These features are particularly advantageous in high-workload and resource-limited settings, where consistent staff adherence and timely interpretation are critical for effective clinical response.

Children who required unplanned PICU transfer demonstrated significantly higher PEWS values at admission, with a marked escalation preceding transfer. Scores increased dynamically reaching mean score of 8.3

immediately prior to transfer, with maximum scores up to 12 ($p < 0.001$), supporting the role of PEWS as a longitudinal indicator of evolving physiological instability rather than a static risk assessment. Similar PEWS trajectories and pre-transfer values have been reported in other prospective and retrospective studies, reinforcing the external validity of these findings [14–16].

Incremental increases in PEWS have been consistently linked to worsening clinical outcomes in hospitalized children. Prior studies demonstrate that each one-point rise more than doubles the likelihood of PICU referral (odds ratio 2.8, $p < 0.001$) [16], while scores exceeding 3–4 are associated with severe illness and the need for escalation of care, in contrast to scores of 0–3, which generally indicate patients who can safely remain on the general ward [15,23]. Importantly, PEWS can identify children at risk a median of more than eleven hours before rapid response activation or cardiorespiratory arrest, providing a critical window for early intervention [17,24– 26].

Notably, nearly half of unplanned PICU transfers in this study occurred within the first 24 hours of admission. This early pattern of deterioration is consistent with findings by Kowalski et al., who reported that the majority of children experiencing clinical deterioration did so within the first 48 hours of arrival to acute care units [27]. Together, these observations emphasize the importance of early PEWS assessment and frequent reassessment during the initial phase of hospitalization, when the risk of deterioration is highest.

Although PEWS is designed as a bedside physiological tool, children requiring PICU transfer in this study also demonstrated more frequent laboratory abnormalities, including anemia, leukocytosis, metabolic acidosis, and renal dysfunction. While laboratory parameters alone are unsuitable for real-time detection of deterioration, their integration with PEWS may improve risk stratification, particularly in children with complex or multisystem involvement. Emerging evidence supports combined clinical and laboratory-based models to enhance predictive accuracy and guide decision-making in pediatric intermediate care settings [28].

A PEWS cutoff value of ≥4 demonstrated excellent predictive performance for unplanned PICU transfer in the present study, with sensitivity of 93.3% and specificity of 98.92%. Nearly half of the PICU transfers occurred within the first 24 hours of admission, predominantly among children with admission PEWS ≥5 who failed to improve or deteriorated further, underscoring the importance of early PEWS assessment during the initial hours of hospitalization. These findings are consistent with prior validation studies identifying cutoff values between 4 and 5 as clinically meaningful thresholds warranting urgent review, intensified monitoring, or escalation of care [15– 17,25].

Supporting the clinical relevance of this threshold, Cheng et al. reported that a PEWS cutoff of approximately 3.5 within the first 24 hours predicted PICU admission with high sensitivity and specificity, while higher scores (≥4.5) were strongly associated with PICU mortality [29]. Collectively, these results suggest a graded

relationship between PEWS values and illness severity, whereby increasing scores not only signal the need for escalation but also reflect progressively higher risk of adverse outcomes.

Beyond predicting clinical deterioration, PEWS assessed at admission has demonstrated prognostic value for broader clinical outcomes. Paterson et al. and Rameteke et al. reported significant correlations between admission PEWS and both in-hospital mortality and length of stay, with mortality rates increasing almost linearly as PEWS values rose [30,31]. Notably, mortality approached 100% among children with admission PEWS scores of 8, underscoring the potential role of PEWS as an early marker of disease severity and overall prognosis.

Analysis of individual PEWS components in this study revealed that abnormalities in heart rate, respiratory rate, respiratory effort, and oxygen saturation were the most sensitive indicators of impending deterioration. These parameters reflect early physiological compensation, characterized by increased work of breathing and autonomic responses aimed at maintaining oxygen delivery before circulatory collapse occurs [32–35]. PEWS scores correlated strongly with these respiratory parameters, reinforcing their predictive value for clinical deterioration. In this cohort, respiratory abnormalities accounted for approximately two-thirds of unplanned PICU transfers, underscoring their central role in early deterioration detection.

In contrast, systolic blood pressure and capillary refill time did not reliably differentiate between children who required PICU transfer and those who remained stable. This observation is physiologically plausible, as hypotension represents a late manifestation of pediatric shock, typically occurring only after compensatory mechanisms have begun to fail [11,36]. While blood pressure remains essential for comprehensive assessment, its limited sensitivity for early deterioration has prompted several contemporary PEWS models to deprioritize or exclude it as a primary trigger, a strategy supported by current evidence and guideline recommendations [4,11,28].

Importantly, a five of children with elevated admission PEWS score of 5 did not progress to require PICU transfer, including 14 with respiratory disease and one with a cardiovascular condition. Rather than reflecting a limitation of PEWS, this observation highlights its role as an early warning and response system. Pediatric patients may sustain prolonged compensatory physiology, during which timely interventions, such as oxygen therapy, intravenous fluids, antimicrobial treatment, bronchodilators, or blood transfusion, can reverse deterioration and restore stability [25,37,38]. PEWS scores may therefore fluctuate in response to both disease progression and therapeutic interventions, emphasizing the importance of close monitoring and clinical judgment in score interpretation.

Collectively, these findings support the routine implementation of bedside PEWS in pediatric intermediate care units. PEWS provides a reliable, non-invasive, and cost-effective framework for early identification of

children at risk of deterioration, facilitating timely escalation of care and efficient resource utilization. Its value is particularly pronounced in resource-limited settings, where continuous monitoring and PICU availability may be constrained. Successful implementation depends on standardized staff training, consistent scoring practices, and clearly defined escalation pathways to ensure that abnormal scores prompt appropriate clinical action.

Limitations

This study was conducted at a single center, which may limit the generalizability of the findings to institutions with different patient populations, care models, or resource availability. The relatively small number of unplanned PICU transfers constrained the statistical power for subgroup analyses. In addition, inter-observer variability inherent to manual scoring systems could affect accuracy, and only one PEWS model was evaluated. Nevertheless, the prospective design, standardized assessments, and strong predictive performance support the internal validity and clinical relevance of the results.

Conclusion

The bedside Pediatric Early Warning Score is a practical, reliable, and dynamic tool for the early detection of clinical deterioration in children admitted to pediatric intermediate care units. Elevated PEWS at admission and progressive increases during hospitalization were strongly associated with unplanned PICU transfer, providing a critical window for timely intervention. Routine integration of PEWS into clinical practice, supported by structured staff training and clearly defined escalation protocols, has the potential to enhance patient safety, improve clinical outcomes, and optimize healthcare resource utilization.

Recommendations

Future multicenter studies are warranted to refine optimal PEWS thresholds across diverse pediatric populations and care settings, and to evaluate the impact of PEWS-guided interventions on clinical outcomes. Structured, continuous training programs for nurses, pediatric residents, and medical officers are essential to ensure consistent implementation and maximize the clinical benefits of PEWS in pediatric intermediate care units.

References

1. Nadkarni VM, Larkin GL, Peberdy MA, Carey SM, Kaye W, Mancini ME, et al.; National Registry of Cardiopulmonary Resuscitation Investigators. First documented rhythm and clinical outcome from in- hospital cardiac arrest among children and adults. JAMA. 2006;295(1):50–57.

2. Berg RA, Vanden Hoek TL, Hickey RW, et al. Part 12: Pediatric advanced life support: 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation. 2007;116(25 Suppl):e100–e108.

3. Chong SL, Goh MSL, Ong GY, Acworth J, Sultana R, Yao SHW, et al. Do paediatric early warning systems reduce mortality and critical deterioration events among children? A systematic review and meta- analysis. Resusc Plus. 2022;11:100262.

4. Monaghan A. Detecting and managing deterioration in children. Paediatr Nurs. 2005;17(1):32–35.

5. Hodgetts TJ, Kenward G, Vlachonikolis IG, Payne S, Castle N. The identification of risk factors for cardiac arrest and formulation of activation criteria to alert a medical emergency team. Resuscitation. 2002;54(2):125–131.

6. Fraser D, Singh R, Frewen T. Early warning systems in pediatric practice: a review of the evidence. J Crit Care. 2006;21(4):289–297.

7. Frost J, Wise MP. Early recognition of sick children in hospital: pediatric track and trigger systems. Crit Care Med. 2012;40(9):2736–2742.

8. Bains RS, Soni N. Pediatric early warning scores for identifying deteriorating children: a systematic review. Paediatr Child Health. 2012;17(4):e62–e69.

9. Castagno E, Balbo M, Procacci A, Parisi A, Paglia F, Bergese I, et al. Early warning scores of clinical deterioration in pediatric patients: a literature review. Assist Inferm Ric. 2023;42(3):137–151.

10. Vohra WI, Rehman A, Aslam A, Khan S, Abbas Q. Paediatric Early Warning Score to detect deterioration in paediatric patients at a tertiary care hospital of a developing country: a validation study. J Coll Physicians Surg Pak. 2023;34(10):1189–1193.

11. Parshuram CS, Hutchison J, Middaugh K. Development and initial validation of the Bedside Paediatric Early Warning System score. Crit Care. 2009;13:R135.

12. Sun WZ, Maconochie IK, et al. Pediatric early warning systems: rationale and supportive evidence for use in pediatric clinical settings. Pediatr Emerg Care. 2012;28(12):1145–1152.

13. Jaimovich DG; American Academy of Pediatrics Committee on Hospital Care and Section on Critical Care. Admission and discharge guidelines for the pediatric patient requiring intermediate care. Pediatrics. 2004;113(5):1430–1433.

14. Parshuram CS, Hutchison J, Middaugh K, Donnelly K; PEWS Study Group. Development and initial validation of the Bedside Pediatric Early Warning System score. Crit Care. 2011;15(4):R184.

15. Solevåg AL, Eggen EH, Schrøder J, Nakstad B. Use of a modified pediatric early warning score in a department of pediatric and adolescent medicine. PLoS One. 2013;8:e72534.

16. Tucker KM, Brewer TL, Baker RB, Demeritt B, Vossmeyer MT. Prospective evaluation of a pediatric inpatient early warning scoring system. J Spec Pediatr Nurs. 2009;14(2):79–85.

17. Duncan H, Hutchinson J, Parshuram CS. The Pediatric Early Warning System score: a severity of illness score to predict urgent medical need in hospitalized children. J Crit Care. 2006;21(3):271–278.

18. Haque A, Bano S. Improving outcome in pediatric intensive care units in academic hospitals in Pakistan. Pak J Med Sci. 2009;25(4):605–608.

19. Bradley JS, Byington CL, Shah SS, et al.; Pediatric Infectious Diseases Society and the Infectious Diseases Society of America. The management of community-acquired pneumonia in infants and children older than 3 months of age: clinical practice guidelines. Clin Infect Dis. 2011;53(7):e25–e76.

20. Villa de Villafañe AA, Panattieri ND, Torres S, et al. Unplanned transfer of pediatric patients from the general ward to the intensive care unit. Arch Argent Pediatr. 2023;121:e202202772.

21. Panesar R, Polikoff LA, Harris D, Mills B, Messina C, Parker MM. Characteristics and outcomes of pediatric rapid response teams before and after mandatory triggering by an elevated Pediatric Early Warning System score. Hosp Pediatr. 2014;4(3):135–140.

22. Alaji NA, Alrashidi ASN, Alotaibi AMQ, Altowairgi SM. Predictive value of pediatric early warning scores for respiratory deterioration in the emergency department: a systematic review. Saudi J Med Pharm Sci. 2025;11(5):408–413.

23. Parwaiz A, Agrawal N, Gupta A, Simalti A, Kedarnath M. Utility of Pediatric Early Warning Score at admission to predict the need for critical care support within 24–48 hours in children. J Pediatr Crit Care. 2024;11(1):15–18.

24. Agulnik A, Gossett J, Carrillo AK, Kang G, Morrison RR. Abnormal vital signs predict critical deterioration in hospitalized pediatric hematology-oncology and post-hematopoietic cell transplant patients. Front Oncol. 2020;10:354.

25. Akre M, Finkelstein M, Erickson M, Billman G. Sensitivity of the Pediatric Early Warning Score to identify patient deterioration. Pediatrics. 2010;125(4):e763–e769.

26. Bracken A, Lane S, Siner S, et al. Assessing the performance of paediatric early warning scores to predict critical deterioration events in hospitalised children (DETECT study). BMC Pediatr. 2025;25:520.

27. Kowalski R, Smith A, Lee J, et al. Accuracy and monitoring of PEWS prior to emergent transfer to PICU. J Pediatr Acute Care. 2021;15(3):123–130.

28. Shin Y, Cho KJ, Lee Y, et al. Multicenter validation of a deep-learning-based pediatric early-warning system for prediction of deterioration events. Acute Crit Care. 2022;37(4):654–666.

29. Cheng Y, Zhang X, Zhang J, Lu G. Application of the Pediatric Early Warning Score in an emergency observation unit. J Pediatr Nurs. 2022;66:1–5.

30. Paterson R, MacLeod DC, Thetford D, et al. Prediction of in-hospital mortality and length of stay using an early warning scoring system: a clinical audit. Clin Med (Lond). 2006;6(3):281–284.

31. Ramteke S, Tikkas R, Jain A. Pediatric early warning score as a prognostic indicator in critically ill children: a prospective study. Indian J Pediatr Res. 2018;5(2).

32. Brisca G, Pepino C, Mariani M, et al. Optimizing pediatric intermediate care: clinical predictors of deterioration and length of stay in a tertiary setting. J Clin Med. 2025;14(18):6398.

33. Tume LN. Early warning systems in pediatric wards: review of unplanned ICU admissions. Intensive Care Med. 2007;33(5):845–850.

34. Haines C, Perrott M, Weir P. Evaluation of an early warning scoring system for hospitalized pediatric patients. Pediatr Crit Care Med. 2006;7(6):525–529.

35. Freedman MS, Forno E. Initial emergency department vital signs may predict PICU admission in pediatric patients presenting with asthma exacerbation. J Asthma. 2023;60(5):960–968.

36. Van Kuiken DM, Huth MM. Predictive value of systolic blood pressure in pediatric early warning systems. J Pediatr Nurs. 2013;28(5):437–443.

37. Habibi Zoham M, Mohammadpour M, Yaghmaie B, et al. Validity of Pediatric Early Warning Score in predicting unplanned pediatric intensive care unit readmission. J Pediatr Intensive Care. 2021;12(4):312– 318.

38. Wheeler DS, Basu RK. Pediatric shock: an overview. Open Pediatr Med J. 2013;7:2–9.